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Application No.: 10/034,848
Filed: December 26, 2001
TC Art Unit: 1762
Confirmation No.: 9636

Rev 12/04

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P.O. Box 1450
Alexandria, VA 22313-1450

Date: December 20, 2004

Attorney Docket No.: BDL-374XX

Sir:

In re application of: Eric Sion et al.

Entitled: METHOD AND INSTALLATION FOR DENSIFYING POROUS SUBSTRATES BY CHEMICAL VAPOUR INFILTRATION

Transmitted herewith is a **Brief for Appellant** and a check for **$500.00** to cover the cost of filing fees in the above-identified application. The following checked items are applicable:

[X] The Commissioner is hereby authorized to charge payment of any additional filing fees under §1.16 associated with this communication or credit any overpayment to Deposit Account No. 23-0804.

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Beverly E. Hjorth

Attorney of Record: Beverly E. Hjorth
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SUBMIT IN TRIPLICATE
BEH/dkh/315148

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application	:	Eric Sion et al.
Application No.	:	10/034,848
Filed	:	December 26, 2001
Confirmation No.	:	9636
For	:	METHOD AND INSTALLATION FOR DENSIFYING POROUS SUBSTRATES BY CHEMICAL VAPOUR INFILTRATION
Examiner	:	Bret P. Chen
Attorney's Docket	:	BDL-374XX

TC Art Unit: 1762

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By: Beverly E. Hjorth
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BRIEF FOR APPELLANT

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PATENT

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BRIEF FOR APPELLANT

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Sir:

Applicants hereby appeal from the Office Action dated July 14, 2004, rejecting claims 1-13 of the above-identified patent application. A Notice of Appeal was timely filed on October 14, 2004, and received by the U.S. Patent and Trademark Office on October 18, 2004.

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REAL PARTY IN INTEREST

The real party in interest in the assignee, Messier-Bugatti.

RELATED APPEALS AND INTEFERENCES

None.

STATUS OF CLAIMS

Claims 1-13 are rejected.

Claims 1-13 are being appealed.

Claims 14-24 have been withdrawn from consideration as being directed to a nonelected invention.

STATUS OF AMENDMENTS

No amendment to the claims has been filed subsequent to a final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

The presently claimed invention relates to a method for densifying porous substrates by chemical vapor infiltration in an oven using a reactive gas containing at least one gaseous precursor for the matrix material (page 3, lines 12-13; page 8, lines 12-15; page 14, lines 12-16). The reactive gas is both heated after it enters the oven upstream of the substrates and prior to entering the oven (page 3, lines 28-36).

More particularly, substrates 32 are loaded for densification in a loading zone 30 of the oven 10 (page 3, lines 21-22). The substrates are heated in the oven to raise them to a temperature at which the desired matrix material is formed from the precursor gas(es) contained in the reactive gas (page 3, lines 23-26). The reactive gas is preheated prior to entering into the oven 10 by

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passing through a preheater device 60 or 80, so that on entering into the oven it is brought to an intermediate temperature between ambient temperature and the temperature to which the substrates are heated (page 3, lines 32-36; page 8, lines 20-31). The preheated reactive gas is then admitted to one end of the oven 10 via inlet 22 (page 3, line 27). The reactive gas is further heated after it has entered into the oven 10 by passing it through a gas heating zone 50 situated upstream from the loading zone 30 in the flow direction of the reactive gas in the oven (page 3, lines 28-31).

Preheating the reactive gas outside the oven enables the heating zone situated within the oven to be more effective in bringing the reactive gas to the desired temperature as soon as it penetrates into the substrate loading zone (page 4, lines 1-5; page 9, lines 21-27; page 11, lines 4-14).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

I. <u>PRIOR ART REJECTIONS</u>

A. Claims 1-13 have been rejected under 35 U.S.C. § 103(a) over Leluan et al. (US Pat. No. 6,001,419) or Robin-Brosse et al. (US Pat. No. 6,410,088) in view of either Christin et al. (US Pat. No. 5,904,957) or Vaudel (US Pat. No. 5,362,228).

B. Claims 1-13 have been rejected under § 103(a) over Christin et al. or Vaudel.

II. <u>DOUBLE PATENTING REJECTIONS</u>

A. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 17 of U.S. Patent No. 6,572,371 (Sion et al.).

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B. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-8 of U.S. Patent No. 6,001,419 in view of Vaudel.

C. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-14 of U.S. Patent No. 5,789,026 in view of Vaudel.

D. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-6 of U.S. Patent No. 5,738,908 (Rey et al.).

E. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-7 of U.S. Patent No. 5,652,030 in view of Vaudel.

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ARGUMENT

I. PRIOR ART REJECTIONS

A. Claims 1-13 have been rejected under 35 U.S.C. § 103(a) over Leluan et al. (US Pat. No. 6,001,419) or Robin-Brosse et al. (US Pat. No. 6,410,088) in view of either Christin et al. (US Pat. No. 5,904,957) or Vaudel (US Pat. No. 5,362,228).

1. Claims 1-13.

The present invention relates to a method of densifying porous substrates by chemical vapor infiltration in which a reactive gas is preheated prior to entering into an oven. Thus, on entering the oven, the gas is brought to an intermediate temperature between ambient temperature and the temperature to which the substrates to be infiltrated within the oven are heated.

As set forth in Applicants' specification (page 4, lines 1-5):

> Preheating the reactive gas outside the loading zone enables the heating zone situated within the oven to be more effective in bringing the reactive gas to the desired temperature as soon as it penetrates into the substrate loading zone.

The specification further states (page 11, lines 4-20):

> Thus preheating the gas serves to avoid a temperature gradient liable to give rise to a significant gradient in densification between substrates situated at the bottom of the stack and the other substrates.
>
> The Applicants estimate that increasing the efficiency of the heating zone 50 so as to make it possible without gas preheating to achieve a result similar to that obtained with gas preheating would require at least 5% of the loading volume to be taken for that purpose. Preheating the reactive gas outside the oven thus makes it possible to improve oven productivity significantly.

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> In addition, preheating to 500°C conserves its effectiveness with a significantly increased flow rate since the temperature at the inlet to the loading zone was about 950°C (curve C [in Fig. 2]). Preheating thus makes it possible to increase the flow rate of the reactive gas, which is favorable to decreasing the total duration of the densification process.

Preheating the gas outside the loading zone is, however, subject to difficulties and therefore not obvious. As also set forth in Applicants' specification (page 4, lines 10-17):

> Nevertheless, it is preferable for the temperature to which the gas is preheated not to exceed 900°C, or even 600°C, in order to avoid any unwanted deposits due to the precursor(s) being transformed prior to penetrating into the oven, and in order to make it possible to use relatively ordinary materials for the pipework feeding the oven with preheated reactive gas and for components such as valves and gaskets mounted in said pipework.

Leluan and Robin-Brosse relate to the chemical vapor infiltration of porous substrates. The Examiner acknowledges that neither Leluan nor Robin-Brosse discloses pre-heating the gas. (Office Action, 7/14/04, page 3) The Examiner cites Vaudel and Christin et al. for teaching the preheating of an admitted gas.

In support of this position, the Examiner cites (Office Action, 7/14/04, page 3) to Christin at column 1, lines 52-65. This portion of Christin states:

> In an industrial installation for chemical vapor infiltration, it is usual to load the reaction chamber with a plurality of substrates or preforms to be densified simultaneously, by using support tooling comprising, in particular, trays and spacers. When the preforms are annular, they may be stacked in a longitudinal direction of the reaction chamber. The gas containing the precursor(s) of the material to be deposited within the preforms is admitted at one longitudinal end of the chamber, while the residual gas is evacuated from the opposite end where it is extracted

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> by pumping means. Means are generally provided to preheat the gas before it reaches the preforms to be densified, e.g. means in the form of perforated preheating plates through which the gas passes on being admitted into the reaction chamber. (Emphasis added.)

The mentioned preheating means is disclosed in more detail as a preheating zone 8. See, for example, Fig. 1, and col. 5, lines 19-25. Christin clearly discloses that the preheating zone 8 is located at the bottom portion of the chamber 1, into which annular preforms 2 are loaded. However, Christin provides no teaching or suggestion whatsoever with respect to the claimed preheating of the reactive gas prior to entering into the oven.

Thus, even if Leluan and Christin or Robin-Brosse and Christin were combined in the manner proposed by the Examiner, the resultant combination would not be the presently claimed invention as set forth in claim 1. Accordingly, claim 1 and the claims dependent therefrom are believed to be patentable over Leluan or Robin-Brosse in view of Christin.

The alternative combinations of Leluan and Vaudel or Robin-Brosse and Vaudel also fail to render the claimed invention obvious. Vaudel fails to teach or suggest preheating a reactive gas prior to entering an oven in addition to heating the reactive gas after it has entered the oven, as claimed.

Vaudel plainly states: "[t]he reactive gas entering the enclosure 12 comes firstly into contact with preheating apparatus 40 placed at the top of the charge of substrates 24." (Col. 4, lines 1-3 (emphasis added)) Thus, the preheating of the gas noted by the Examiner (Office Action, 7/14/04, page 3) at col. 2, lines 40-50, of Vaudel refers to preheating inside the oven.

Thus, the combinations of Leluan and Vaudel or Robin-Brosse and Vaudel also fail to arrive at the invention set forth in claim

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1. Thus, independent claim 1 and the claims dependent therefrom are patentably distinguishable thereover.

2. Claims 2-7.

Regarding claims 2-7, the Examiner states that it would have been obvious to have determined the optimum value of a cause effective variable such as temperature and pressure through routine experimentation in the absence of a showing of criticality. However, each of claims 2-7 is at least partly directed to variations of the initially claimed step of preheating the reactive gas outside of the oven. It cannot be a matter of mere optimization to claim specific aspects of an underlying feature of the invention (preheating the reactive gas prior to entering the oven) when that underlying feature is not taught or suggested by the prior art of record.

Additionally, claims 2-4 recite aspects of the claimed invention having non-trivial operational effects, as described in the specification at, for example, page 9, line 28, to page 11, line 14. Accordingly, claims 2-7 are believed to be patentable over the cited prior art for these reasons as well.

More particularly, claim 2 (and claim 3 as dependent from claim 2) recites that the substrates are raised to a temperature greater than 900°C and the reactive gas is preheated, prior to entering the oven, so as to be raised to a temperature of not less than about 200°C on entering into the oven. The temperature of not less than about 200°C for the reactive gas is preferred for the preheating to be most effective in this situation to avoid a significant temperature gradient in the loading zone. (page 9, lines 21-30)

Claim 4 recites that the reactive gas is preheated to a temperature no greater than 600°C prior to entering the oven. As

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stated in Applicant's specification, the preheating temperature should be limited to avoid forming unwanted deposits (soot) in the feed pipe 62 and to allow use of affordable materials for the components such as the pipe, valve, and gaskets. (Page 9, line 31, to page 10, line 7)

Dependent claim 5 is directed to passing the reactive gas through a heat exchanger prior to entering the oven. This claim has no relationship to specific temperatures or pressures or any other form of result effective variables, and falls outside of the Examiner's routine experimentation argument.

Accordingly, these claims are believed to be patentable for these reasons as well.

B. Claims 1-13 have been rejected under § 103(a) over Christin et al. or Vaudel.

As noted above in Section I.A., Christin does not disclose, teach, or suggest a method including both heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of a loading zone in the oven, and preheating the reactive gas prior to entering the oven, as set forth in independent claim 1. Christin clearly discloses that the preheating zone 8 is located within the chamber 1 into which the preforms 2 are loaded. (Fig. 1; col. 5, lines 19-25) Christin provides no teaching or suggestion to preheat the reactive gas prior to entering the oven. Accordingly, claim 1 and the claims dependent therefrom are believed to be patentable over Christin.

Similarly, Vaudel does not disclose, teach, or suggest a method including both heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of a loading zone in the oven, and preheating the reactive gas prior to

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entering the oven, as set forth in independent claim 1. Vaudel clearly discloses a preheating apparatus inside the oven. (Col. 2, lines 40-50) Vaudel provides no teaching or suggestion to preheat the reactive gas prior to entering the oven. Accordingly, claim 1 and the claims dependent therefrom are believed to be patentable over Vaudel.

II. DOUBLE PATENTING REJECTIONS

A. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 17 of U.S. Patent No. 6,572,371 (Sion et al.).

The Examiner asserts that the claims are not patentably distinct because the elimination of a plurality of stacks is an obvious variation. This assertion is not relevant to the presently claimed invention. Claim 17 of Sion recites:

> 17. A process for controlling distribution of preheated reactive gas in a CVI furnace for densification of annular porous substrate loaded in a reaction chamber of the furnace in a plurality of vertical stacks, each stack comprising superposed substrates defining an internal volume of the stack, the reaction chamber being heated by a susceptor having an internal wall delimiting the reaction chamber,
>
> said process comprising admitting the reactive gas into a preheating zone at the bottom of the furnace, preheating the reactive gas by passing it through the preheating zone, dividing the preheated reactive gas into a plurality of separate flows at respective outlets of the preheating zone, and directing the separate flows of reactive gas into respective internal volumes of the stacks of annular substrates,
>
> wherein the separate flows of reactive gas are adjusted as a function of the location of the corresponding stacks of substrates within the reaction chamber.

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As is apparent, Sion does not recite in claim 17 the steps of both heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of a loading zone in the oven, and of preheating a reactive gas prior to entering an oven, as set forth in independent claim 1. Accordingly, the claims are patentably distinct from each other, and the double patenting rejection is not proper.

B. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-8 of U.S. Patent No. 6,001,419 (Leluan et al.) in view of Vaudel (US Pat. No. 5,362,228).

The Examiner asserts that the conflicting claims are not patentable distinct from each other because preheating gases in a CVI process is an obvious variation as noted in Vaudel.

Independent claim 1 of Leluan provides as follows:

1. A chemical vapor infiltration method for infiltrating a same material into a porous substrate by means of a gas containing at least a precursor of said material in the gaseous state,

said method comprising placing the porous substrate in an enclosure, introducing the gas into the enclosure, exhausting residual gas from the enclosure, and controlling infiltration conditions defined by a set of parameters including: the gas retention time between introduction into the enclosure and exhaustion from the enclosure, the pressure within the enclosure, the temperature of the substrate, the concentration of the precursor in the gas, and the concentration of any dopant in the gas,

wherein said infiltration conditions are controllably modified during the course of the infiltration process by varying at least one of said parameters between a first value at the start of the infiltration process and a second value different from the first value during or at the end of the infiltration process, with said gas retention time, if varied, being

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increased from a first to a second value, with said temperature, if varied, being decreased from a first to a second value, with said precursor concentration, if varied, being decreased from a first to a second value and with said dopant concentration, if varied, being decreased from a first to a second value,

thereby adapting the infiltration conditions to changes in the porometry of the substrate; and

wherein said same material is infiltrated as said infiltration conditions are controlled from a beginning to an end.

As can be seen, Leluan does not claim preheating a reactive gas. As noted above, Vaudel does not disclose, teach, or suggest the steps of both heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of a loading zone in the oven, and of preheating a reactive gas prior to entering an oven (Vaudel, col. 2, lines 40-50), as set forth in independent claim 1 of the present invention. Also, the presently claimed invention does not claim controlling the infiltration conditions as set forth in claim 1 of Leluan. Accordingly, the claims are patentably distinct from each other, and the double patenting rejection is not proper.

C. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-14 of U.S. Patent No. 5,789,026 (Delperier et al. '026) in view of Vaudel (US Pat. No. 5,362,228).

The Examiner asserts that that claims are not patentably distinct because preheating gases in a CVI process in an obvious variation an noted in Vaudel, and in addition, the elimination of recited materials is obvious. Independent claim 1 of Delperier et al. '026 is as follows:

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1. A method of densifying a porous substrate with a pyrolytic carbon matrix obtained by chemical vapor infiltration, the method comprising the following steps:

placing the substrate in an enclosure;

heating the substrate so as to enable a temperature gradient to be established within the substrate so that the substrate has a higher temperature in portions remote from its exposed surfaces than at said surfaces; and

admitting into the enclosure a gas that constitutes a precursor of carbon, comprising at least one saturated or unsaturated hydrocarbon, with the formation of pyrolytic carbon being favored in the higher temperature portions of the substrate;

the method being characterized in that:

the gas comprises a mixture made up of at least one saturated or unsaturated hydrocarbon together with hydrogen; and

the temperature gradient established within the substrate is such that the hottest internal portions of the substrate are at a temperature which is higher than 1500 K., and at which deposition of the pyrolytic carbon is activated by the presence of hydrogen, and the exposed external portions of the substrate are at a temperature which is lower than 1500 K., and at which deposition of the pyrolytic carbon is inhibited by the presence of hydrogen.

As can be seen, Delperier '026 does not claim preheating a reactive gas. As noted above, Vaudel does not disclose, teach, or suggest the steps of <u>both</u> heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of a loading zone in the oven, <u>and</u> preheating a reactive gas <u>prior to entering an oven</u> (Vaudel, col. 2, lines 40-50), as set forth in independent claim 1 of the present invention. Also, the presently claimed invention does not claim establishing a temperature gradient as set forth in claim 1 of Delperier '026. Accordingly,

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the claims are patentably distinct from each other, and the double patenting rejection is not proper.

D. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-6 of U.S. Patent No. 5,738,908 (Rey et al.).

The Examiner asserts that the claims are not patentably distinct because the elimination of temperatures and pressures is an obvious variation. This assertion is not relevant to the presently claimed invention. Claim 1 of Rey recites:

> 1. A method of densifying a porous substrate by chemical vapor infiltration of silicon carbide, the method comprising:
>
> placing the substrate in an infiltration chamber;
>
> injecting a reaction gas comprising methyltrichlorosilane and hydrogen into the infiltration chamber having a flow rate ratio of hydrogen to methyltrichlorosilane of 5:1 to 10:1;
>
> preheating the gas entering the infiltration chamber so as to bring it up to a temperature of 960°C. to 1050°C. before making contact with the substrate;
>
> maintaining a temperature within the range of 960°C. to 1050°C. and a pressure of not more than 25 kPa within the infiltration chamber, whereby a fraction of the reaction gas is allowed to react and form a deposit of silicon carbide within the porous substrate, leaving a residual gas which comprises silicon-containing species including undecomposed methyltrichlorosilane and gaseous by-products of decomposition of methyltrichlorosilane; and
>
> extracting the residual gas from the infiltration chamber by pumping through a pipe connected to an outlet of the infiltration chamber, while causing the concentration of the silicon-containing species in the residual gas to be lowered immediately at the outlet from the infiltration chamber to avoid the formation of unstable condensates on walls of said pipe.

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As is apparent, Rey does not claim both heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of a loading zone in the oven, and preheating a reactive gas prior to entering an oven, as set forth in independent claim 1. Accordingly, the claims are patentably distinct from each other, and the double patenting rejection is not proper.

E. Claims 1-13 have been rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-7 of U.S. Patent No. 5,652,030 (Delperier et al. '030) in view of Vaudel (US Pat. No. 5,362,228).

The Examiner asserts that the claims are not patentably distinct because preheating gases in a CVI process is an obvious variation as noted in Vaudel. Independent claims 1 and 5 of Delperier et al. '030 are as follows:

1. A method for infiltrating a material into a porous substrate by chemical vapor infiltration, comprising the steps of:

placing the substrate in an enclosure;

heating the substrate in the enclosure by causing a current to flow through an induction winding located outside the enclosure, said heating being performed so as to create a temperature gradient within the substrate such that the temperature T_s at an exposed surface of the substrate is lower than the temperature in portions of the substrate remote from said exposed surface;

admitting into said enclosure a reaction gas that includes a precursor for the material to be infiltrated, transformation of the precursor into said material being enhanced in portions of the substrate of higher temperature;

measuring the temperature of the substrate at the exposed surface; and

controlling the current flowing through the induction winding at the beginning of the infiltration process and at least during the major portion thereof,

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in order to maintain the temperature at the exposed surface at a value which is no greater than a minimum deposition temperature required for said material to be formed, while temperature in portions of the substrate remote from the exposed surface is greater than said minimum deposition temperature.

5. A method for infiltrating a material into a porous substrate by chemical vapor infiltration, comprising the steps of:

providing a substrate made of an electrically conductive material;

placing the substrate in an enclosure;

heating the substrate in the enclosure by causing a current to flow through an induction winding located outside the enclosure, and induction coupled directly with the substrate, said heating being performed so as to create a temperature gradient within the substrate such that the temperature T_s at an exposed surface of the substrate is lower than the temperature in portions of the substrate remote from said exposed surface;

admitting into said enclosure a reaction gas that includes a precursor for the material to be infiltrated, transformation of the precursor into said material being enhanced in portions of the substrate of higher temperature;

measuring the temperature of the substrate at the exposed surface; and

controlling the current flowing through the induction winding at the beginning of the infiltration process and at least during the major portion thereof, in order to maintain the temperature at the exposed surface at a value which is no greater than a minimum deposition temperature required for said material to be formed, while the temperature in portions of the substrate remote from the exposed surface is greater than said minimum deposition temperature.

As can be seen, Delperier '030 does not claim preheating a reactive gas. As noted above, Vaudel does not disclose, teach, or suggest the steps of <u>both</u> heating a reactive gas after it enters an oven by passing the gas through a gas heating zone upstream of

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a loading zone in the oven, and preheating a reactive gas prior to entering an oven (Vaudel, col. 2, lines 40-50), as set forth in independent claim 1 of the present invention. Also, the presently claimed invention does not claim controlling current flow as set forth in claims 1 and 5 of Delperier '030. Accordingly, the claims are patentably distinct from each other, and the double patenting rejection is not proper.

CONCLUSION

For the reasons set forth above, reversal of the rejection of claims 1-13 is respectfully requested.

Respectfully submitted,

ERIC SION ET AL.

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CLAIMS APPENDIX

1. (Previously Presented) A method of densifying porous substrates with a matrix obtained by chemical vapour infiltration using a reactive gas containing at least one gaseous precursor for the matrix material, the method comprising the steps of:

- loading substrates for densification in a loading zone of an oven;
- heating the substrates in the oven so as to raise them to a temperature at which the desired matrix material is formed from the precursor gas(es) contained in the reactive gas;
- admitting the reactive gas to one end of the oven; and
- heating the reactive gas after it has entered into the oven by passing it through a gas heating zone situated upstream from the loading zone in the flow direction of the reactive gas in the oven;
- wherein the reactive gas is preheated prior to entering into the oven so that on entering into the oven it is brought to an intermediate temperature between ambient temperature and the temperature to which the substrates are heated.

2. (Original) A method according to claim 1, wherein the substrates are raised to a temperature greater than 900°C and the reactive gas is preheated, prior to entering the oven, so as to be raised to a temperature of not less than about 200°C on entering into the oven.

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3. (Original) A method according to claim 2, wherein the reactive gas is preheated to a temperature no greater than 900°C prior to entering the oven.

4. (Original) A method according to claim 2, wherein the reactive gas is preheated to a temperature no greater than 600°C prior to entering the oven.

5. (Original) A method according to claim 1, wherein the reactive gas is preheated outside the oven by passing through a heat exchanger.

6. (Original) A method according to claim 1, wherein the reactive gas is preheated outside the oven at a pressure which is substantially equal to the pressure that exists inside the oven.

7. (Original) A method according to claim 1, wherein the reactive gas is preheated outside the oven at a pressure which is higher than that which exists in the oven, and is expanded prior to entering into the oven.

8. (Original) A method according to claim 1, for densifying porous annular substrates for brake disks made of carbon/carbon composite material.

9. (Original) A method according to claim 8, wherein the substrates are loaded into the oven in one or more annular stacks and the reactive gas from the gas heating zone is channeled into one of the two volumes constituted by the volume(s) inside the annular stack(s) and by the volume of the loading zone outside the

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annular stack(s), and an effluent gas is taken from the other one of the two volumes to be evacuated from the oven.

10. (Original) A method according to claim 9, wherein the substrates are stacked so as to leave leakage passages between them, putting said two volumes into communication with each other.

11. (Original) A method according to claim 9, wherein the substrates are stacked without leaving leakage passages between them, so that the reactive gas can pass from one of said two volumes to the other solely by passing through the pores of the substrates.

12. (Original) A method according to claim 9, wherein the annular stacks are individually fed with reactive gas via respective passages through a wall of the oven.

13. (Original) A method according to claim 12, wherein the preheating temperature of the reactive gas feeding the stacks of substrates is adjusted individually for each stack.

14. (Withdrawn) An installation for densifying porous substrates by chemical vapour infiltration, the installation comprising :

- an oven,
- a zone for loading substrates into the oven,
- means for heating substrates in the loading zone,
- at least one inlet for admitting reactive gas into the oven,
- at least one gas heating zone situated in the oven between the reactive gas inlet and the loading zone, and

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- at least one gas preheating device situated outside the oven and connected to at least one reactive gas inlet to the oven, so as to preheat the reactive gas before it enters the oven.

15. (Withdrawn) An installation according to claim 14, wherein the preheating device comprises an electrical heater tube inserted in a duct for feeding reactive gas to the reactive gas inlet of the oven.

16. (Withdrawn) An installation according to claim 14, wherein the preheating device comprises a gas boiler having at least one duct passing therethrough to convey a flow of reactive gas to be preheated.

17. (Withdrawn) An installation according to claim 16, wherein the boiler is connected to an outlet for removing effluent gas from the oven so as to use at least a fraction of the effluent gas as fuel gas for the boiler.

18. (Withdrawn) An installation according to claim 14, wherein the preheating device comprises an electrically heated oven having at least one tube passing therethrough to carry a flow of reactive gas to be preheated.

19. (Withdrawn) An installation according to claim 14, further including an expander located between the preheating device and the inlet for reactive gas into the oven.

20. (Withdrawn) An installation according to claim 14, wherein the preheating device includes temperature regulator means.

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21. (Withdrawn) An installation according to claim 14, for densifying annular substrates placed in a plurality of stacks, the installation including a plurality of heater zones each situated between a respective inlet for reactive gas into the oven and a respective location for an annular stack in the loading zone.

22. (Withdrawn) An installation according to claim 21, having a plurality of individual feed pipes for preheated reactive gas connected to the reactive gas inlets into the oven.

23. (Withdrawn) An installation acorn to claim 22, wherein the individual feed pipes are connected to a preheating device via a common pipe.

24. (Withdrawn) An installation according to claim 22, wherein the individual feed pipes are connected to respective devices for preheating reactive gas.

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RELATED PROCEEDINGS APPENDIX

None.

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